REMARKS

Claims 1-22 remain in the application and have been amended to specify that the objects are spatial objects. New claims 23-32 have been added by amendment. No new matter has been added.

Claim Rejections - 35 USC § 112

First Paragraph

Claims 1-22 were rejected under the first paragraph of 35 USC § 112. Applicant hereby incorporates all of the previous arguments filed April 24, 2003 and again traverses this ground of rejection.

The Final Office Action states that "[t]he examiner asserts that the specification does not sufficiently disclose <u>how new spatial objects are 'created'</u> or <u>how they are applied to the reference coordinate systems</u> to describe bodies in three dimensional space..." (emphasis in original). Applicant respectfully submits that this position is erroneous.

As an initial matter, Applicant reminds the Examiner that the first paragraph of 35 USC § 112 does not require disclosure of that which is well known to one of ordinary skill in the art. In the present case, Applicant need not disclose the mechanics of well-known mathematical concepts such as how to add vectors, how to find the derivative of a function over time, etc. Indeed, it is inherent that hard-coding of spatial objects in known in the admitted prior art. However, to assist the Examiner, some of these basic principles are presented herein.

A *vector* has direction and magnitude, but no location in space. *Axes* have orientation in space, but no location. Axes can be interpreted as three mutually orthogonal unit magnitude vectors called a triad. A *point* has location, but no orientation. A *coordinate system* has a location defined by its origin, which is a point, and it has orientation defined by its axes. In other words, any coordinate system can be constructed from any point and axes. An *angle* is a scalar number, which in a strict mathematical sense has no orientation, however, angles can be built from vectors, thus giving them associated orientations. A *plane* is a two dimensional construct that has orientation and location in three-dimensional space. Its orientation is defined by its normal vector and another reference vector. Its location is defined by its reference point.

While a vector can be identified in various forms, all of them must relate to some reference axes. A well known method uses Cartesian form, which includes three components of the vector. Each component is a projection of the vector onto on of three triad vectors of the

reference axes. In other words, the vector exists regardless of whether there are reference axes, but its Cartesian components can only be defined some reference axes.

Similarly with axes, since they are constructed based on vector triad: axes exist regardless of reference axes, but in order to compute axes orientation the reference axes must be selected. Orientation can be represented in various forms as well and it is known in the art to use quaternia and direction cosine matrices.

A point's location in space can be computed using a location vector from some other known reference point. This means that, for that vector, reference axes are also needed to compute Cartesian components. Hence, a combination of reference point and reference axes is needed to compute a point's location. That combination is called a coordinate system, as described above.

A coordinate system represents axes attached to a point and, based on the discussion above, it means that its orientation and location can be computed relative to some other reference coordinate system. Additionally, as a scalar angle is a reference independent construct, yet is based on vectors, there is an implied reference relative to which vectors' components are found for angle computations.

Plane computations are very similar to coordinate systems: a plane's reference point must be located in some reference coordinate system and plane's orientation must be defined in some reference axes.

Because all of the geometric constructs discussed above can be moving (changing location and/or orientation) relative to each other, finding their time derivatives also depends on the references. A vector's time derivative is another vector, such that not only its components but its magnitude and direction can be different in different reference axes. For example, a vector can be fixed in one axes (i.e., have a zero derivative), but be moving in another axes (i.e., have a non-zero derivative).

The time derivative of an axes is an angular velocity vector, which similarly depends on a reference axes. Likewise, the time derivative of a point is a velocity vector, which depends on a reference coordinate system. The time derivative of a coordinate system is comprised from a velocity vector of its origin and an angular velocity vector of its axes. They depend on a reference coordinate system.

Geometric and derivative operations are needed when vectors or points are not explicit. Instead, components of these objects are known/given at a time relative to a known reference. In this case, the question may arise how these components will change when observed in a different reference. One of skill in the art knows how to perform operations between different references (axes or coordinate systems) to re-compute vectors or point components in another reference. Often, these operations involve the creation of geometric constructs.

Two types of creation operation can be identified - geometric and time based. The former is the most straightforward and has the most variety, including, but not limited to:

- Vector creation - cross product, displacement, fixed in axes
- Axes creation - aligned/constrained based on two vectors, fixed in axes
- Point creation - fixed in coordinate system, central body shape based (e.g. grazing point), covariance based (e.g. covariance ellipsoid grazing point)
- Coordinate system - assembled from axes and point
- Angle - between vectors, between planes, dihedral angle, between vector and plane
- Plane - using three points, using quadrant of coordinate system

The time based constructs include, but are not limited to:

- Vector creation - fixed in time as another vector in reference axes, angular velocity vector of axes in reference axes, vector derivative in reference axes
- Axes creation - fixed in time as another axes in reference axes
- Point creation - fixed in time as another point in coordinate system
- Plane - using point trajectory (displacement and velocity vectors relative to reference point).

Based upon these well known concepts, Applicant submits that the mechanics related to creation spatial objects and their application to reference coordinate systems need not be disclosed for compliance with the first paragraph of 35 USC 112.

However, the specification DOES, in fact, disclose numerous instances of "how new spatial objects are 'created'" or "how they are applied to the reference coordinate systems":

- Page 1, line 16 to page 2, line 10,
  "In the planning and analysis of spacecraft maneuvers, the creation of vectors, axes, points, coordinate systems and other elements and combinations thereof is required in order to describe the position and motion of rigid bodies in three-dimensional space (e.g., spacecraft orbits, trajectories, and maneuvers).

When a coordinate system must be created, the relationship of the new system to a pre-existing one is defined. There are many ways to define that relationship, but all must include the following: (1) a specification of how the origin of the new coordinate system is translated relative to the origin of the existing system, and (2) a specification of how the set of three orthogonal axes defining the orientation of the new system is rotated relative to the set of axes of the existing system.

This introduces two important coordinate concepts that are part of any coordinate system definition: (1) origin point, and (2) axes. Given a point in space (i.e., an 'origin') and a set of axes oriented in space, one can create a coordinate system by combining the point and the axes.

If there is a plurality of points and axes, one can create any desired combination thereof, thus increasing the number of possible coordinate systems."

- Page 2, lines 16-23,

"Another component useful in constructing a coordinate system is the vector. The vector relates to points and axes in a number of ways. A new point can be specified by a vector starting at a pre-defined point. A new vector can be defined on the basis of two existing points, starting and ending. A new set of orthogonal axes can be specified by using two non-parallel vectors. A new vector can be created by performing various vector operations (rotation about another vector, cross-product, negation, etc.). Thus, vectors, along with points and axes, provide useful building blocks for constructing new coordinate systems.

- Page 7, line 10 to page 8, line 8,

"The present invention provides a GUI and software architecture that empowers the user to create new vectors, axes, points, coordinate systems, and other elements, and combinations thereof, in the following ways:

1) specifying a point explicitly relative to an existing coordinate system;

2) specifying a vector explicitly relative to an existing set of axes;

3) specifying a set of axes explicitly relative to an existing set of axes;

4) specifying a coordinate system explicitly relative to an existing coordinate system;

5) defining a point by an existing vector (i.e., the end point);

6) defining a vector by two points (i.e., start point and end point);

7) defining a vector by one or more existing vectors via vector operations (e.g., cross product);

8) defining a set of coordinate axes by two non-parallel vectors; and

9) defining a coordinate system as a combination of a point (origin) and a set of coordinate axes.

The explicit means of creating coordinate systems and primitives (items 1-4, above) are carried out via user input, imported data from files or any other means of supplying numerical data to computer programs. In addition to geometrical relationships, coordinate system definitions can describe rates of change in the primitives, thus providing additional ways to create vectors:

a. the rate of change of a vector constitutes another vector;

b. the rate of change of a point (i.e., its velocity) constitutes a vector; and

c. the rate of change of axes (rate of rotation or angular rate) constitutes a vector."

Further, the Examiner's reliance on "undue experimentation" in the Office Action is completely misplaced. The spatial objects in the present invention, such as, but not limited to, points, axes, vectors, and coordinate systems, are ***mathematical constructs*** that are ***defined by*** *mathematical/geometric principles* such that they ***cannot possibly involve any experimentation*** whatsoever.

Applicant has NOT invented any new mathematical constructs, *per se*, but has rather invented a way to make existing constructs more useful, especially in the area of modeling orbital maneuver phenomena on a computer, by defining new constructs (new spatial objects or target objects) based upon existing constructs (parent spatial objects or parent objects) so that spacecraft maneuver analysts don't have to keep "reinventing the wheel" by hard-coding objects. Instead, the present invention allows them to reuse and adapt existing objects.

Furthermore, some of the Examiner's statements border on the ridiculous, such as when questioning how one finds a point object in an existing coordinate system - which can be found by determining the corresponding x, y, and z coordinates - or how to find a vector object in an existing axes object - which can be found by projecting each Cartesian component of the vector onto the axes triad.

For the above-mentioned reasons, Applicant submits that the written description satisfies the requirements of the first paragraph of 35 USC § 112 and requests reconsideration.

Second Paragraph

Claims 1-22 were also rejected under the second paragraph of 35 USC § 112 as being indefinite. Applicant hereby incorporates all of the previous arguments filed April 24, 2003 and again traverses this ground of rejection.

With regard to the Examiner's response to Applicant previously presented "combined transformation" arguments, Applicant further submits that the claim terminology is clear to one of ordinary skill in the art. For example, *Merriam-Webster's Dictionary* defines "transformation" as "**3 a** (1) : the operation of changing (as by rotation or mapping) one configuration or expression into another in accordance with a mathematical rule; *especially* : a change of variables or coordinates in which a function of new variables or coordinates is substituted for each original variable or coordinate (2) : the formula that effects a transformation, **b** : a mathematical correspondence that assigns exactly one element of one set to each element of the

same or another set." (Attached hereto as Exhibit A). Additionally, the inputs and various parent spatial objects are the subject of daily work for spacecraft maneuver analysts, such that the statement in the Office Action that "one skilled in the art would be at odds to determine what the objects represent or exactly what the user inputs are" is ludicrous. And finally, the Examiner's reference to "hierarchical data techniques" and "simple data search techniques" have NO application, whatsoever, to the *presently claimed spatial objects.*

To assist the Examiner in understanding the skill level of one of skill in the art at the time of the invention and the environment in which the present invention is deployed, Applicant has included copies of some of the help files produced for the STK Astrogator product in October of 1999, attached hereto as Exhibit B (along with a file listing showing the creation date of the files).

For the above-mentioned reasons, Applicant submits that the claims satisfy the requirements of the second paragraph of 35 USC § 112 and requests reconsideration.

Claim Rejections - 35 USC § 102

Claims 1-22 were rejected under 35 USC § 102(a) as being clearly anticipated by the Lilly publication. Applicant traverses this ground of rejection. Lilly discloses the modeling of orbiting and rotating bodies using VRML. As previously stated, although the Lilly publication uses the words "object," "transformation," and "coordinates" and deals with modeling orbiting and rotating bodies, it has nothing to do with the present invention. The term "object" in Lilly refers to *modeled physical objects*, such as a planetary body or its satellite, not *spatial objects*, such as points, vectors, axes, and coordinate systems, as used and claimed in the present invention. "Transformation" in Lilly is cited with respect to the UTF8 superset of ASCII, not the transformation of *spatial objects*, as used in the presently claimed invention. "Transform" in Lilly is a keyword of VRML that is merely used to create viewed objects in the *given* x, y, z coordinate system, much as "PositionInterpolater" is a VRML keyword translates bodies to the specified x, y, and z coordinates, such that it is clear that Lilly defines viewed bodies within a *single coordinate system* - thereby making the present invention entirely unnecessary within the system of Lilly. Indeed, as Lilly quite clearly discloses the ***hard-coding of VRML***, it is abundantly evident that new spatial objects are not defined with respect to pre-existing spatial objects, and especially not from within a GUI.

Claims 1-22 were rejected also under 35 USC § 102(e) as being clearly anticipated by Shapiro et al. Applicant also traverses this ground of rejection.

As previously submitted, although Shapiro et al., unlike Lilly, at least involves multiple coordinate systems, it also has little to do with the present invention. The term "object," again, refers to physical objects and not the claimed spatial objects, and the Shapiro et al. patent is drawn to the determination of the largest subset of points (a *subset* of spatial objects) that remains within a set of points S (*set* of spatial objects) when S is subjected to motion. The system uses an iterative process (see figures 13, 14 and 15) and does no finding of a target (spatial) object in terms of each parent (spatial) object or building operation to obtain a combined transformation based on the parent objects wherein *the target object is created by the combined transformation of the parent objects*, as required by the present claims.

Indeed, 35 USC 102 requires that "[t]he identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). Shapiro et al.'s invention in the machining art is so far afield of the present invention as to be non-analogous in addition to non-anticipatory art.

In view of the above arguments, Applicant respectfully submits that claims 1-22 are novel and non-obvious over the cited prior art.

New Claims

New claims 23-32 are allowable over the prior art since none of the prior art discloses the creation of new spatial objects to model orbital maneuver phenomena on a computer without needing to hard-code a software solution.

Conclusion

For the reasons cited above, Applicants submit that claims 1-32 are in condition for allowance and requests reconsideration of the application. If there remain any issues that may be disposed of via a telephonic interview, the Examiner is kindly invited to contact the undersigned at the local exchange given below.

Respectfully submitted,
ROBERTS ABOKHAIR & MARDULA, LLC

Christopher B. Kilner

Christopher B. Kilner, Esq.
Registration No.: 45,381
(703) 391-2900